increases, simplified and unobtrusive means for monitoring the physiologic parameters of a patient become more important.

[0006] Patient compliance is critical to the success of such systems and is often directly correlated to the ease of use and unobtrusiveness of the monitoring solution used.

[0007] Existing monitoring systems are often prone to false alarms, usage related failures, unreliable user interfaces, cumbersome interfaces, artifact or electromagnetic interference (EMI) related interference, etc. Such problems decrease productivity of using these systems, can result in lost data, and lead to dissatisfaction on the part of both the subject being monitored and the practitioners monitoring the subject. In the case of a hospital setting, the continual drone of alarms can lead to alarm fatigue and decreased productivity.

[0008] Long term compliance of subjects may suffer due to uncomfortable interfaces with monitoring devices, involved maintenance or change-over of disposables, painful or itchy reactions to materials in the devices, and the like.

[0009] More reliable, redundant, and user friendly systems are needed that can provide valuable patient data even when operating with limited supervision, expert input, or user manipulation.

SUMMARY

[0010] One illustrative, non-limiting objective of this disclosure is to provide systems, devices, methods, and kits for monitoring physiologic and/or physical signals from a subject. Another illustrative, non-limiting objective is to provide simplified systems for monitoring subjects. Another illustrative, non-limiting objective is to provide comfortable long term wearable systems for monitoring subjects. Yet another illustrative, non-limiting objective is to provide systems for facilitating interaction between a user and a subject with regard to physiologic monitoring of the subject.

[0011] The above illustrative, non-limiting objectives are wholly or partially met by devices, systems, and methods according to the appended claims in accordance with the present disclosure. Features and aspects are set forth in the appended claims, in the following description, and in the annexed drawings in accordance with the present disclosure.

[0011a] According to a first aspect, there is provided a patch interface, comprising: a substrate with a surface; an adhesive coupled to the substrate, the adhesive being formulated for attachment to the skin of a subject; an interconnect embedded into or coupled to the substrate, the interconnect being configured for attachment of the patch interface to a microcircuit; and a plurality of microelectrodes attached to or embedded into the surface of the substrate and electrically coupled with the microcircuit. via the interconnect; and one or more macroelectrodes electrically coupled with the microcircuit via the interconnect; wherein the patch interface is configured to monitor neural activity from the skin of the subject; wherein the microcircuit comprises two or more processing banks, a first one of the two or more processing banks being coupled to: at least a first one of the one or more macroelectrodes; and a first subset of the plurality of microelectrodes; and wherein the first processing bank comprises a first preamplifier bank and a first switch bank, the first switch bank being configured to selectively connect one or more of the microelectrodes in the first subset of the plurality of microelectrodes and the first macroelectrode to the first preamplifier bank, the first preamplifier bank comprising one or more conditioning circuits configured to utilize signals measured by the first macroelectrode to remove at least one of one or more stretch artifacts and one or more movement artifacts from signals measured by the connected one or more microelectrodes in the first subset of the plurality of microelectrodes.

[0012] According to a first embodiment there is provided a system for monitoring one or more physiologic and/or physical signals from a subject including one or more patches each in accordance with the present disclosure configured for attachment to the subject, and one or more modules each in accordance with the present disclosure configured and dimensioned to mate with a corresponding patch, and to interface with the subject there through. In embodiments, one or more of the modules may be configured to convey and/or store one or more physiologic and/or physical signals, a signal derived therefrom, and/or a metric derived therefrom obtained via the interface with the subject.

[0013] In embodiments, the system may include or interface with a host device in accordance with the present disclosure coupled in wireless communication with one or more of the modules configured to receive one or more of the signals and/or metrics therefrom. In embodiments, the host device may include features for recharging and/or performing diagnostic tests on one or more of the modules.

[0014] According to embodiments there is provided, use of a system in accordance with the present disclosure to monitor a subject, to monitor an electrocardiogram of a subject, to perform one or more tasks in accordance with the present disclosure, etc.

[0015] According to embodiments there is provided an interface (i.e. a patch in accordance with the present disclosure) for monitoring a physiologic and/or physical signal from a subject, including a substrate, an adhesive coupled to the substrate formulated for attachment to the skin of a subject, and one or more sensors and/or electrodes each in accordance with the present disclosure coupled to the substrate, arranged, configured, and dimensioned to interface with the subject.

[0016] In embodiments, the substrate may be formed from an elastic or polymeric material and the patch is configured to maintain operation when stretched to more than 25%, more than 50%, or more than 80%.

[0017] In embodiments, the interface (i.e. the patch) may be configured with a moisture vapor transmission rate of between 200 grams/square meter (g/m^2)/24 hours (hrs) and 20,000g/m^2/24hrs, between 500g/m^2/24hrs and 12,000g/m^2/24hrs, or between 2,000g/m^2/24hrs and 8,000g/m^2/24hrs, etc.

[0018] In embodiments, the interface may be used for a range of applications, some non-limiting examples of which include electrocardiography, sleep assessment,

bruxism assessment, sleep apnea, traumatic brain injury, black box event based monitoring (e.g. for syncope, atrial fibrillation, etc.), biofeedback, stress management, relaxation, physiotherapy, stroke or surgical recovery, or the like. Additional uses and details thereof are described throughout the present disclosure.

[0019] According to embodiments there is provided a device (i.e. a module in accordance with the present disclosure) for monitoring a physiologic, physical, and/or electrophysiological signal from a subject including, a housing, a printed circuit board (PCB) including one or more microcircuits, and an interconnect configured for placement of the device onto a subject interface (i.e. a patch in accordance with the present disclosure).

[0020] In embodiments, the printed circuit board may constitute at least a portion of the housing.

[0021] In embodiments, the device may include a three dimensional antenna coupled to the microcircuits (i.e. coupled with a transceiver, transmitter, radio, etc. included within the microcircuits). In embodiments, the antenna may be printed onto or embedded into the housing.

[0022] According to another embodiments there is provided a kit for monitoring a physiologic, physical, and/or electrophysiological signal from a subject, including one or more patches in accordance with the present disclosure, one or more modules in accordance with the present disclosure, a recharging bay in accordance with the present disclosure, and one or more accessories in accordance with the present disclosure.

[0023] In embodiments, one or more of the accessories may include an adhesive removing agent configured to facilitate substantially pain free removal of one or more of the patches from a subject.

[0024] According to another embodiment there is provided, a service system for managing the collection of physiologic data from a customer, including a customer data management service, configured to generate and/or store the customer profile referencing customer preferences, data sets, and/or monitoring sessions, an automated product delivery service configured to provide the customer with one or more monitoring products or supplies in accordance with the present disclosure, and a datacenter configured to store, analyze, and/or manage the data obtained from the customer during one or more monitoring sessions.

[0025] In embodiments, the service system may include a report generating service configured to generate one or more monitoring reports based upon the data obtained during one or more monitoring sessions, a report generating service coupled to the datacenter configured to generate one or more monitoring reports based upon the data obtained during one or more monitoring sessions, and/or a recurrent billing system configured to bill the customer based upon the number of patches consumed, the data stored, and/or the reports generated throughout the course of one or more monitoring session.

[0026] According to another embodiment there is provided a method for monitoring a physiologic, physical, and/or electrophysiological signal from a subject, including one or more steps in accordance with the present disclosure.

[0027] In embodiments, one or more of the steps may be performed at least in part by a system in accordance with the present disclosure.

[0028] According to another embodiment there is provided, an isolating patch for providing a barrier between a handheld monitoring device with a plurality of contact pads and a subject, including a flexible substrate with two surfaces, a patient facing surface and an opposing surface, and an electrically and/or ionically conducting adhesive coupled to at least a portion of the patient facing surface configured so as to electrically and mechanically couple with the subject when placed thereupon, wherein the conducting adhesive is exposed within one or more regions of the opposing surface of the substrate, the regions patterned so as to substantially match the dimensions and layout of the contact pads.

[0029] In embodiments, the conducting adhesive may include an anisotropically conducting adhesive, with the direction of conduction oriented substantially normal to the surfaces of the substrate.

[0030] According to another embodiment there is provided, a patch interface (i.e. a patch in accordance with the present disclosure) for monitoring one or more physiologic and/or electrophysiological signals from a subject, including a substrate, an adhesive coupled to the substrate formulated for attachment to the skin of a subject, an interconnect embedded into the substrate for attachment of the patch to a microcircuit, and one or more sensors and/or electrodes attached to or embedded onto the surface of

the substrate, the sensors and/or electrodes arranged, configured, and dimensioned to interface with the subject when the adhesive is attached thereto.

[0031] In embodiments, the adhesive may be patterned onto the substrate so as to form one or more exposed regions of the substrate, one or more of the sensors and/or electrodes arranged within the exposed regions. One or more of the electrodes may include an inherently or ionically conducting gel adhesive.

[0032] In embodiments, one or more of the electrodes may include an electrode feature arranged so as to improve the electrical connection between the electrode and the skin upon placement on a subject. In embodiments, the improved electrical connection may be achieved after pressure is applied to the electrode (i.e. after the patch is secured to the subject and then a pressure is applied to the electrode). The electrode feature may include one or more microfibers, barbs, microneedles, or spikes to penetrate into a stratum corneum of the skin. The electrode feature may be configured to penetrate less than 2mm into the skin, less than 1mm, less than 0.5mm, less than 0.2mm, or the like during engagement therewith. In embodiments, a gel adhesive in accordance with the present disclosure located adjacent to the electrode features (i.e. between the features and the skin) may be configured to maintain the improved electrical connection to the skin for more than 1 hr, more than 1 day, or more than 3 days after the electrode contacts the skin or pressure is applied to the electrode.

[0033] In embodiments, a patch interface in accordance with the present disclosure may include one or more stretchable electrically conducting traces attached to the substrate, arranged so as to couple one or more of the sensors and/or electrodes with one or more of the interconnects.

[0034] In embodiments, the interconnect may include a plurality of connectors, the connectors physically connected to each other through the substrate. The patch may include an isolating region arranged so as to isolate one or more of the connectors from the skin while the patch is engaged therewith.

[0035] In embodiments, the patch interface may be sufficiently physically frail such that it cannot retain a predetermined shape in a free standing state. The patch interface may include a temporary stiffening member attached to the substrate, the temporary stiffening member configured to provide retention of the shape of the patch interface prior to attachment to the subject, the stiffening member being removable from the

substrate after attachment to the subject. In embodiments, after removal of the stiffening member, the retention of the shape of the patch interface may be provided by the skin of the subject. Removal of the patch interface from the skin of the subject may result in a permanent loss in shape of the patch interface without tearing of the patch interface. In embodiments, the interconnect may be sufficiently frail such that removal of the patch interface from the skin of the subject may result in a permanent loss of shape of the interconnect.

[0036] In embodiments, an adhesive in accordance with the present disclosure may have a peel tack to mammalian skin of greater than 0.02 Newton/millimeter (N/mm), greater than 0.1N/mm, greater than 0.25N/mm, greater than 0.50N/mm, greater than 0.75N/mm, or the like. The patch interface may have a tear strength of greater than 0.5N/mm, greater than 1N/mm, greater than 2N/mm, greater than 8N/mm, or the like.

[0037] In embodiments, a patch interface in accordance with the present disclosure may have a ratio between the tear strength of the patch and the peel tack of the adhesive to mammalian skin that is greater than 8:1, greater than 4:1, greater than 2:1, or the like. In embodiments, the substrate may be formed from a soft pseudo-elastic material and the patch interface may be configured to maintain operation when stretched to more than 25%, more than 50%, more than 80%, or the like. In embodiments, the patch interface may be configured with a moisture vapor transmission rate of between 200g/m^2/24hrs and 20,000g/m^2/24hrs, between 500g/m^2/24hrs and 12,000g/m^2/24hrs, between 1,000g/m^2/24hrs and 8,000g/m^2/24hrs, or the like.

[0038] According to another embodiment, there is provided a module for monitoring one or more physiologic and/or electrophysiological signals from a subject, including a housing, a circuit board including one or more microcircuits, and a module interconnect coupled to one or more of the microcircuits configured for placement and coupling of the device onto a patch interface in accordance with the present disclosure.

[0039] In embodiments, the module interconnect may be embedded into the circuit board, and/or the circuit board may constitute at least a portion of the housing. The module may include a three dimensional antenna in accordance with the present disclosure, the antenna coupled to one or more of the microcircuits, the microcircuits including a transceiver or transmitter coupled to the antenna. In embodiments, the antenna

may be printed on an interior wall of or embedded into the housing, the circuit board providing a ground plane for the antenna. In embodiments, the housing may be shaped like a dome and the antenna may be patterned into a spiraling helix centered within the dome.

[0040] In embodiments, a module in accordance with the present disclosure may include a sensor coupled with one or more of the microcircuits, the sensor configured to interface with the subject upon attachment of the module to the patch interface. The module may include a sensor and/or microelectronics configured to interface with a sensor included on a corresponding patch interface. In embodiments, one or more of the sensors may include an electrophysiologic sensor, a temperature sensor, a thermal gradient sensor, a barometer, an altimeter, an accelerometer, a gyroscope, a humidity sensor, a magnetometer, an inclinometer, an oximeter, a colorimetric monitor, a sweat analyte sensor, a galvanic skin response sensor, an interfacial pressure sensor, a flow sensor, a stretch sensor, a microphone, a combination thereof, or the like.

[0041] In embodiments, the module may be hermetically sealed. The module and/or patch interface may include a gasket coupled to the circuit board or the substrate, the gasket formed so as to isolate the region formed by the module interconnect and the patch from a surrounding environment, when the module is coupled with the patch.

[0042] According to another embodiment there is provided, a device for monitoring one or more physiologic and/or electrophysiologic signals from a subject including a patch interface in accordance with the present disclosure and a module in accordance with the present disclosure. In embodiments, the module interconnect included within the module may be sized and dimensioned to interface with a corresponding interconnect included within the patch interface, wherein to form an operable interconnection between the patch interface and the module, the patch interface may first be coupled to the subject (i.e. so as to maintain the shape thereof during the process of coupling the patch interface to a corresponding module).

[0043] In embodiments, the module interconnect may include an electrically conducting magnetic element, and the patch interface may include one or more ferromagnetic regions coupled to the substrate, the magnetic elements arranged so as to physically and/or electrically couple the module to the patch interface when the magnetic elements are aligned with the ferromagnetic regions. In embodiments, the ferromagnetic

regions may be formed from stretchable pseudo elastic material and/or may be printed onto the substrate. In aspects, the module and/or the patch interface may include one or more fiducial markings to visually assist with the alignment of the module to the patch during coupling thereof.

[0044] According to another embodiment there is provided, a system for monitoring one or more physiologic and/or electrophysiological signals from a subject including a patch interface in accordance with the present disclosure configured for attachment to the subject, and a module in accordance with the present disclosure configured and dimensioned to mate with the patch, and to interface with the subject there through, the module configured to convey and/or store one or more physiologic, electrophysiological, and/or physical signals, a signal derived therefrom, and/or a metric derived therefrom obtained via the interface with the subject.

[0045] In embodiments, the system may include a host device coupled in wireless communication or physical communication with the module, configured to receive one or more of the signals and/or metrics therefrom. In embodiments, the host device may include one or more features for recharging and/or performing diagnostic tests on one or more of the modules. In embodiments, the system may include a plurality of modules, the modules being hot swappable with the patch interface, so as to maintain a nearly continuous or continuous operation thereof.

[0046] In embodiments, the system may include a plurality of modules and associated patch interfaces for placement onto a signal subject, the host device, and/or one or more of the modules configured to coordinate synchronous monitoring of the signals amongst the modules on the subject. In embodiments, a host device in accordance with the present disclosure may be integrated into a bedside alarm clock, housed in an accessory, within a purse, a backpack, a wallet, or is included in a mobile computing device, a smartphone, a tablet computer, a pager, a laptop, a local router, a data recorder, a network hub, a server, a secondary mobile computing device, a repeater, a combination thereof, or the like.

[0047] According to another embodiment there is provided, use of a device, a module, a patch, and/or a system each in accordance with the present disclosure to monitor an electrocardiogram of a subject.

[0047a] In another aspect, there is provided a module, comprising: a housing; a circuit board comprising one or more microcircuits, the circuit board coupled to the housing; and a module interconnect coupled to one or more of the microcircuits, the module interconnect being configured for placement and coupling of the module onto a patch interface, the patch interface comprising: a substrate with a surface; an adhesive coupled to the substrate, the adhesive being formulated for attachment to the skin of a subject; a patch interconnect embedded into or coupled to the substrate, the patch interconnect being configured for attachment of the patch interface to the microcircuit; and a plurality of microelectrodes attached to or embedded into the surface of the substrate and electrically coupled with the microcircuit via the patch interconnect; and

one or more macroelectrodes electrically coupled with the microcircuit via the patch interconnect; wherein the module is configured to monitor one or more of physiologic signals, physical signals, skin based neural activity, and electrophysiological signals from the subject; wherein the microcircuit comprises two or more processing banks, a first one of the two or more processing banks being coupled to: at least a first one of the one or more macroelectrodes; and a first subset of the plurality of microelectrodes; and wherein the first processing bank comprises a first preamplifier bank and a first switch bank, the first switch bank being configured to selectively connect one or more of the microelectrodes in the first subset of the plurality of microelectrodes and the first macroelectrode to the first preamplifier bank, the first preamplifier bank comprising one or more conditioning circuits configured to utilize signals measured by the first macroelectrode to remove at least one of one or more stretch artifacts and one or more movement artifacts from signals measured by the connected one or more microelectrodes in the first subset of the plurality of microelectrodes.

[0048] According to another embodiment there is provided, a method for monitoring one or more physiologic and/or electrophysiological signals from a subject, including attaching one or more soft breathable and hypoallergenic devices to one or more sites on the subject, obtaining one or more local physiologic and/or electrophysiological signals from each of the devices, and analyzing the signals obtained from each of the devices to generate a metric, diagnostic, report, and/or additional signals therefrom.

[0049] In embodiments, the method may include hot swapping one or more of the devices without interrupting the step of obtaining, and/or calibrating one or more of the devices while on the subject. In embodiments, the step of calibrating may be performed with an additional medical device (e.g. a blood pressure cuff, a thermometer, a pulse oximeter, a cardiopulmonary assessment system, a clinical grade electrocardiogram (EKG) diagnostic system, etc.).

[0050] In embodiments, the method may include determining the position and/or orientation of one or more of the devices on the subject, and/or determining the position and/or orientation from a photograph, a video, or a surveillance video.

[0051] In embodiments, one or more steps of a method in accordance with the present disclosure may be performed at least in part by a device, patch interface, module, and/or system each in accordance with the present disclosure.

[0052] According to another embodiment there is provided, an isolating patch for providing a barrier between a handheld monitoring device with a plurality of contact pads and a subject, including a flexible substrate with two surfaces, a patient facing surface and an opposing surface, and an electrically and/or ionically conducting adhesive coupled to at least a portion of the patient facing surface configured so as to electrically and mechanically couple with the subject when placed thereupon, wherein the conducting adhesive is exposed within one or more regions of the opposing surface of the substrate, the regions patterned so as to substantially match the dimensions and layout of the contact pads.

[0053] In embodiments, the conducting adhesive may include an anisotropically conducting adhesive, with the direction of conduction oriented substantially normal to the surfaces of the substrate.

[0054] According to another embodiment there is provided, a system for measuring blood pressure of a subject in an ambulatory setting including an EKG device in accordance

with the present disclosure (i.e. a patch/module pair in accordance with the present disclosure configured to measure local electrophysiological signals in adjacent tissues), configured for placement onto a torso of the subject, the EKG device configured to measure an electrocardiographic signal from the torso of the subject so as to produce an EKG signal, one or more pulse devices (i.e. patch/module pairs in accordance with the present disclosure configured to measure local blood flow in adjacent tissues) each in accordance with the present disclosure, configured for placement onto one or more sites on one or more extremities of the subject, each of the pulse devices configured to measure a local pulse at the placement site so as to produce one or more pulse signals, and a processor included in or coupled to one or more of the EKG device and the pulse devices, the processor configured to receive the EKG signal, the pulse signals, and/or signals generated therefrom, the processor including an algorithm, the algorithm configured to analyze one or more temporal metrics from the signals in combination with one or more calibration parameters, to determine the blood pressure of the subject.

[0055] In embodiments, the system for monitoring blood pressure of a subject may include a blood pressure cuff configured to produce a calibration signal, the processor configured to generate one or more of the calibration parameters, from the calibration signal in combination with the EKG signal, and pulse signals.

[0056] In embodiments, one or more of the devices may include an orientation sensor, the orientation sensor configured to obtain an orientation signal, the processor configured to receive the orientation signal or a signal generated therefrom, and to incorporate the orientation signal into the analysis. Some non-limiting examples of orientation sensors include one or more of an altimeter, a barometer, a tilt sensor, a gyroscope, combinations thereof, or the like.

[0057] In another embodiment there is provided a system for measuring the effect of an impact on physiologic state of a subject including an electroencephalogram (EEG) device (i.e. a patch/module pair in accordance with the present disclosure configured to measure local electrophysiological signals associated with brain activity in adjacent tissues) in accordance with the present disclosure, configured for placement behind an ear, on the forehead, near a temple, onto the neck of the subject, or the like, the EEG device configured to measure an electroencephalographic signal from the head of the subject so as to produce an EEG signal, and configured to measure one or more kinetic and/or

kinematic signals from the head of the subject so as to produce an impact signal, and a processor included in or coupled to the EEG device, the processor configured to receive the EEG signal, the impact signals, and/or signals generated therefrom, the processor including an algorithm, the algorithm configured to analyze the impact signals to determine if the subject has suffered an impact, to separate the signals into pre impact and post impact portions and to compare the pre and post impact portions of the EEG signal, to determine the effect of the impact on the subject.

[0058] In embodiments, the EEG device may include additional sensors such as a temperature sensor configured to generate a temperature signal from the subject or a signal generated therefrom, the processor configured to receive the temperature signal and to assess a thermal state of the subject therefrom. In embodiments, the EEG device may include a hydration sensor configured to generate a fluid level signal from the subject, the processor configured to receive the fluid level signal or a signal generated therefrom, and to assess the hydration state of the subject therefrom.

[0059] In embodiments, the EEG device and/or the processor may include or be coupled to a memory element, the memory element including sufficiently large space to store the signals for a period of 3 minutes, 10 minutes, 30 minutes, or 1 hr.

[0060] In embodiments, the system for measuring the effect of an impact on physiologic state of a subject may include an EKG device (i.e. a patch/module pair in accordance with the present disclosure configured to measure local electrophysiological signals in adjacent tissues) in accordance with the present disclosure, the EKG device configured for placement onto the torso or neck of the subject, the EKG device configured to measure an electrophysiological signal pertaining to cardiac function of the subject so as to produce an EKG signal, the processor configured to receive the EKG signal or a signal generated therefrom, the algorithm configured so as to incorporate the EKG signal into the assessment. In embodiments, the processor may be configured to extract a heart rate variability (HRV) signal from the EKG signal, a pre impact and post impact portion of the HRV signal compared to determine at least a portion of the effect of the impact.

[0061] According to another embodiment there is provided, a system for assessing a sleep state of a subject including an electromyography (EMG)/ electrooculography (EOG) device (i.e. a patch/module pair in accordance with the present disclosure configured to

measure local electromyographic and/or electrooculographic signals from adjacent tissues), in accordance with the present disclosure, configured for placement behind an ear, on a forehead, substantially around an eye, near a temple, or onto a neck of the subject, the EMG/EOG device configured to measure one or more electromyographic and/or electrooculographic signals from the head or neck of the subject so as to produce an EMG/EOG signal, and a processor included in or coupled to the EMG/EOG device, the processor configured to receive the EMG/EOG signal, and/or signals generated therefrom, the processor including an algorithm, the algorithm configured to analyze EMG/EOG signal, to determine the sleep state of the subject.

[0062] In embodiments, the EMG/EOG device may include a microphone, the microphone configured to obtain an acoustic signal from the subject, the processor configured to receive the acoustic signal or a signal generated therefrom, the algorithm configured so as to incorporate the acoustic signal into the assessment.

[0063] In embodiments, the system may include a sensor for evaluating oxygen saturation (sPO2) at one or more sites on the subject to obtain an oxygen saturation signal from the subject, the processor configured to receive the oxygen saturation signal or a signal generated therefrom, the algorithm configured so as to incorporate the oxygen saturation signal into the assessment.

[0064] In embodiments, the processor may include a signal analysis function, the signal analysis function configured to analyze the EMG/EOG signals, the acoustic signal, and/or the oxygen saturation signal to determine the sleep state of the subject, identify snoring, identify a sleep apnea event, identify a bruxism event, identify a rapid eye movement (REM) sleep state, identify a sleep walking state, a sleep talking state, a nightmare, or identify a waking event. In embodiments, the system may include a feedback mechanism, configured to interact with the subject, a user, a doctor, a nurse, a partner, a combination thereof, or the like. The processor may be configured to provide a feedback signal to the feedback mechanism based upon the analysis of the sleep state of the subject. The feedback mechanism may include a transducer, a loudspeaker, tactile actuator, a visual feedback means, a light source, a buzzer, a combination thereof, or the like to interact with the subject, the user, the doctor, the nurse, the partner, or the like.

[0065] According to another embodiment there is provided, a system for assessing a gait and/or a muscle movement of a subject including an EMG device (i.e. a patch/module pair in accordance with the present disclosure configured to measure local electromyographic signals from adjacent tissues) in accordance with the present disclosure, configured for placement over a muscle group on the subject, the EMG device configured to measure one or more electromyographic signals from the muscle group of the subject so as to produce an EMG signal, and a processor included in or coupled to the EMG device, the processor configured to receive the EMG signal, and/or signals generated therefrom, the processor including an algorithm, the algorithm configured to analyze EMG signal to determine at least a portion of the gait and/or the muscle movement of the subject.

[0066] In embodiments, the system may include a plurality of EMG devices, each EMG device configured to monitor a separate muscle group on the subject, the processor configured to synchronize and analyze the EMG signals received from each EMG device to determine at least a portion of the gait and/or the muscle movement of the subject.

[0067] In embodiments, one or more of the EMG devices may include an orientation, kinetic, kinematic, and/or proprioception sensor each in accordance with the present disclosure, configured so as to generate a kinematic signal, the processor configured to incorporate the kinematic signal into the analysis. In embodiments, the processor may be configured to analyze one or more of the EMG signals to generate a muscle exertion metric.

[0068] According to another embodiment there is provided, a patch interface for monitoring neural activity from the skin of a subject, including a substrate with a surface, an adhesive coupled to the substrate formulated for attachment to the skin of a subject, an interconnect embedded into or coupled to the substrate for attachment of the patch to a microcircuit, and a plurality microelectrodes attached to or embedded into the surface of the substrate, the microelectrodes arranged, configured, and dimensioned to interface with the subject when the adhesive is attached thereto, the microelectrodes electrically coupled with the interconnect and/or the microcircuit.

[0069] In embodiments, the adhesive may be patterned onto the substrate so as to form one or more exposed regions of the substrate, one or more of the microelectrodes

arranged within the exposed regions, the adhesive may include an electrically or ionically conducting component, and/or the adhesive may provide a macroelectrode function for interfacing with the subject when attached thereto, the macroelectrode electrically coupled to the interconnect and/or the microcircuit. Such a macroelectrode may provide a guard, reference, or counter electrode function or the like for one or more of the microelectrodes.

[0070] In embodiments, one or more of the microelectrodes may be configured to penetrate into the skin when the adhesive is attached to the subject. One or more of the microelectrodes may have a needle-like shape, the microelectrode including an insulated region and an exposed region (so as to interface with local tissues). The microelectrode may have a length such that the exposed region is positioned within the epidermal layer, the dermal layer, and/or the hypodermal layer of the skin upon attachment of the patch to the surface thereof. In embodiments, one or more of the microelectrodes may be shaped so as to penetrate down a root of a follicle, to reach a sweat gland, a sebaceous gland, a muscle, a vessel, an arrector pili follicular muscle, or the like upon attachment of the patch interface to the skin.

[0071] In embodiments, one or more of the microelectrodes may include an electrode feature in accordance with the present disclosure arranged so as to improve the electrical connection between the microelectrode or an exposed region thereof and the skin upon placement on a subject. In embodiments, the improved electrical connection may be achieved after pressure is applied to the microelectrode.

[0072] In embodiments, the microcircuit may include a switch bank and an amplifier with two or more inputs, the switch bank adaptably configurable to couple one or more of the microelectrodes with an input of the amplifier, and one or more alternative microelectrodes and/or the macroelectrode to another input of the amplifier. The switch bank may be adaptively configurable to connect one or more clusters of microelectrodes to a single input of the amplifier.

[0073] In embodiments, one or more of the microelectrodes may be sized, dimensioned, oriented, configured and shaped so as to penetrate less than 3 millimeters (mm), less than 2mm into the skin, less than 1mm, less than 0.5mm, less than 0.2mm, or the like into the skin during engagement therewith. One or more of the microelectrodes and/or exposed regions thereof may have an active surface area of less than $4mm^2$,

less than $1mm^2$, less than $100,000\mu m^2$, less than $10,000\mu m^2$, less than $1,000\mu m^2$, less than $100\mu m^2$, or the like.

[0074] In embodiments, one or more of the macroelectrodes may have an active surface area of greater $5mm^2$, greater than $50mm^2$, greater than $100mm^2$, greater than $500mm^2$, or the like.

[0075] In embodiments, the macroelectrode may be shaped and/or patterned on the substrate so as to reduce movement artifacts, monitor a macroscopic electrophysiologic field, provide a reference electrode function, provide a guard electrode function, provide a drive electrode function, a combination thereof, or the like during use.

[0076] In embodiments, the patch interface may include a sensor coupled with the substrate, and electrically coupled with the microcircuit, the sensor configured to monitor one or more physiologic parameters of the subject when coupled thereto. Some non-limiting sensor components include an electrophysiologic sensor, a temperature sensor, a thermal gradient sensor, a barometer, an altimeter, an accelerometer, a gyroscope, a humidity sensor, a magnetometer, an inclinometer, an oximeter, a colorimetric monitor, a sweat analyte sensor, a perfusion sensor, a galvanic skin response sensor, a hydration sensor, an interfacial pressure sensor, a flow sensor, a stretch sensor, a microphone, a combination thereof, and the like.

[0077] In embodiments, the patch interface may include a stimulating device selected from an electrical stimulator, a thermoregulating device, a heating coil, a thermoelectric device, a Peltier device, a tactile stimulating component, a vibratory stimulating element, a combination thereof, or the like arranged along the substrate so as to interface with the skin of the subject when the adhesive is attached thereto. In embodiments, the patch interface and/or stimulating device may include a feedback sensor coupled with the stimulating device, configured and arranged so as to monitor the interaction of the stimulating device with the skin during activation thereof.

[0078] In embodiments, the patch interface may include one or more stretchable electrically conducting traces attached to the substrate, arranged so as to couple one or more of the sensors, microelectrodes, and/or macroelectrodes with the interconnect or microcircuit. In embodiments, the patch interface may be sufficiently physically frail such that it cannot retain a predetermined shape in a free standing state.

[0079] In embodiments, the patch interface may include a temporary stiffening member attached to the substrate, the temporary stiffening member configured to provide retention of the shape of the patch interface prior to attachment to the subject, the stiffening member being removable from the substrate after attachment to the subject. In embodiments, after removal of the stiffening member, the retention of the shape of the patch interface may be provided by the skin of the subject, and/or removal of the patch interface from the skin of the subject may result in a permanent loss in the shape of the patch interface without tearing of the patch interface.

[0080] In embodiments, the patch interface may be constructed such that it is sufficiently frail and that removal of the patch interface from the skin of the subject results in a permanent loss of shape of the interconnect. Such a configuration may be advantageous in balancing frailty of the freely supported patch interface against substantially maximizing comfort for the subject during use. In embodiments, the adhesive may have a peel tack to mammalian skin of greater than 0.02N/mm, greater than 0.1N/mm, greater than 0.25N/mm, greater than 0.50N/mm, greater than 0.75N/mm, or the like. In embodiments, the patch may have a tear strength of greater than 0.5N/mm, greater than 1N/mm, greater than 2N/mm, greater than 8N/mm, or the like. In embodiments, the ratio between the tear strength of the patch and the peel tack of the adhesive to mammalian skin may be greater than 8:1, greater than 4:1, greater than 2:1, or the like. In embodiments, the substrate may be formed from a soft pseudo-elastic material and the patch interface may be configured to maintain operation when stretched to more than 25%, more than 50%, more than 80%, or the like. In embodiments, the patch interface may be configured with a through thickness moisture vapor transmission rate of between $200g/m^2/24hrs$ and $20,000g/m^2/24hrs$, between $500g/m^2/24hrs$ and $12,000g/m^2/24hrs$, between $1,000g/m^2/24hrs$ and $8,000g/m^2/24hrs$, or the like.

[0081] In embodiments, the adhesive may include an endothermic-reactive specie, an exothermic-reactive specie, a local analgesic, a neuro-blocker, a neurotoxin, a neural antagonist, and/or a neural agonist. Such components may be advantageous for affecting local neural traffic at a monitoring site on a body with a high degree of specificity.

[0082] According to another embodiment there is provided, a module for monitoring one or more physiologic, physical, skin based neural activity, and/or electrophysiological signals from a subject, including a housing, a circuit board including one or more

microcircuits, the circuit board coupled to the housing, and a module interconnect coupled to one or more of the microcircuits configured for placement and coupling of the module onto a patch interface in accordance with the present disclosure.

[0083] In embodiments, the module interconnect may be embedded into the circuit board, and/or the circuit board may constitute at least a portion of the housing. In embodiments, a three dimensional antenna may be coupled to one or more of the microcircuits, the microcircuits including a transceiver or transmitter coupled to the antenna, and/or the antenna may be printed on an interior wall of or embedded into the housing, the circuit board providing a ground plane for the antenna.

[0084] In embodiments, the housing may be shaped like a dome and the antenna may be patterned into a spiraling helix centered within the dome.

[0085] In embodiments, the module may include a sensor coupled with one or more of the microcircuits, the sensor configured to interface with the subject upon attachment of the module to the patch interface.

[0086] In embodiments, the module may include a sensor and/or microelectronics configured to interface with a sensor included on the patch interface, one or more of the sensors including an electrophysiologic sensor, a temperature sensor, a thermal gradient sensor, a barometer, an altimeter, an accelerometer, a gyroscope, a humidity sensor, a magnetometer, an inclinometer, an oximeter, a colorimetric monitor, a perfusion sensor, a sweat analyte sensor, a galvanic skin response sensor, an interfacial pressure sensor, a flow sensor, a stretch sensor, a microphone, a combination thereof, or the like.

[0087] In embodiments, the module may include a stimulating device selected from an electrical stimulator, a thermoregulating device, a heating coil, a thermoelectric device, a Peltier device, a tactile stimulating component, a vibratory stimulating element, a combination thereof, or the like arranged along the substrate so as to interface with the skin of the subject when coupled to the patch interface.

[0088] In embodiments, the module may be hermetically sealed and/or the module may include a gasket coupled to the circuit board, the gasket shaped so as to isolate the region formed by the module interconnect and the patch from a surrounding environment, when the module is coupled with the patch.

[0089] According to another embodiment there is provided, a device for monitoring one or more physiologic, physical, and/or electrophysiologic signals from a subject including a patch interface in accordance with the present disclosure and a module in accordance with the present disclosure, the module interconnect included within the module, sized and dimensioned to interface with the interconnect included within the patch interface, wherein to form an operable interconnection between the patch interface and the module, the patch interface must first be coupled to the subject.

[0090] In embodiments, the module interconnect may include an electrically conducting magnetic element, and the patch interface may include one or more ferromagnetic regions coupled to the substrate, the magnetic elements arranged so as to physically and electrically couple the module to the patch interface when the magnetic elements are aligned with the ferromagnetic regions.

[0091] In embodiments, one or more of the ferromagnetic regions may be formed from a stretchable pseudo elastic material and may be printed onto the substrate. In embodiments, the module and/or the patch interface may include one or more fiducial markings to visually assist with the alignment of the module to the patch during coupling thereof.

[0092] According to another embodiment there is provided, a system for monitoring one or more physiologic, physical, and/or electrophysiological signals from a subject including a patch interface in accordance with the present disclosure configured for attachment to the subject and a module in accordance with the present disclosure configured and dimensioned to mate with the patch, and to interface with the subject there through, the module configured to convey and/or store one or more physiologic, neural activity, and/or physical signals, a signal derived therefrom, and/or a metric derived therefrom obtained via the interface with the subject.

[0093] In embodiments, the system may include a host device coupled in wireless communication or physical communication with the module, configured to receive one or more of the signals and/or metrics therefrom.

[0094] In embodiments, the host device may include one or more features for recharging and/or performing diagnostic tests on one or more of the modules. In embodiments, the system may include a plurality of modules, the modules being hot swappable with the patch interface, so as to maintain a nearly continuous operation thereof.

[0095] In embodiments, the system may include a plurality of modules and associated patch interfaces for placement onto a single subject, the host device, and/or one or more of the modules configured to coordinate synchronous monitoring of the signals amongst the modules on the subject. In embodiments, the host device may be integrated into a bedside alarm clock, housed in an accessory, within a purse, a backpack, a wallet, or is included in a mobile computing device, a smartphone, a tablet computer, a pager, a laptop, a local router, a data recorder, a network hub, a server, a secondary mobile computing device, a repeater, a combination thereof, or the like.

[0096] According to another embodiment there is provided, use of a device in accordance with the present disclosure, and/or a system in accordance with the present disclosure, to confirm completion of, follow up on, confirm partial completion of, monitor a patient response to, or patient selection in connection with, a denervation procedure, a renal denervation procedure, ablation of a renal nerve, ablation of renal artery, or ablation of an accessory renal artery.

[0097] According to another embodiment there is provided, a method for assessing an autonomic nervous system of a subject, including monitoring neural activity at one or more sites on the skin of the subject to generate one or more signals, performing a stress test on the subject, and analyzing the signals obtained before, during, and/or after the stress test to generate a metric, diagnostic, report, and/or additional signals therefrom relating to the autonomic nervous system of the subject.

[0098] In embodiments, the stress test may include administration of a chemical, a drug, medicament, a hormone, an enzyme, a diuretic, a solution, electrolytes, a peptide, steroid, saline, a hypotonic solution, a hypertonic solution, a combination thereof, or the like to the subject. In embodiments, the administration may be topical, systemic, intravenous, intra-arterial, intra-parenchymal, sub-dermal delivery, transdermal delivery, rectal, via vaginal suppositories, via urethral suppositories, via nasal suppositories, via rectal suppositories, inhaled, a combination thereof, or the like.

[0099] In embodiments, the stress test may include delivery of energy, stimulation of, electrical stimulation of, presenting an audio field to, application of thermal stress to, presenting a light field to, presenting an image to, asking a question to, or playing music for, the subject. In embodiments, the stress test may include providing a tactile input to one or more sites on the subject.

[00100] In embodiments, the stress test may include stimulating one or more of a carotid sinus, a carotid body, a baroreceptor, a vagus nerve receptor, an erogenous zone, or the like of the subject.

[00101] In embodiments, the stress test may include applying an electromagnetic field to, injecting a current into, applying pressure to, applying stroking to, or applying a change in barometric pressure surrounding the subject.

[00102] In embodiments, the stress test may include having the subject sleep, cry, laugh, lie down, jump, walk, run, change posture, exercise, perform a breath holding exercise, climb stairs, or the like.

[00103] In embodiments, one or more of the sites may be coupled to the perineal region, the perianal region, the pubic region, the inner thigh region, the posterior knee region, the neck, the ear, the ocular region, the breast, the axilla, the elbow, the wrist, the palm, the foot, the lips, an erogenous zone of the subject, a combination thereof, or the like.

[00104] In embodiments, one or more of the steps of a method in accordance with the present disclosure may be performed at least in part by a device in accordance with the present disclosure, a system in accordance with the present disclosure, a module in accordance with the present disclosure, and/or a patch interface in accordance with the present disclosure.

[00105] According to another embodiment there is provided, a system for performing a neuromodulation and/or ablation procedure on a target site within a subject including a treatment system for delivering energy or a chemical to the target site, one or more monitoring devices configured to interface with the skin of the subject at one or more monitoring sites on the subject, each of the monitoring devices configured to measure one or more electrophysiological signals, neural traffic signals, and/or physiologic parameters from the monitoring sites so as to produce an activity signal, and a processor included in or coupled to one or more of the monitoring devices, the processor configured to receive the activity signal(s), and/or one or more signals generated therefrom, the processor including an algorithm, the algorithm configured to analyze the activity signal(s) to determine the effect of the treatment system on the target site.

[00106] In embodiments, the algorithm may be configured to compare the activity signal(s) generated by a plurality of monitoring devices against each other to determine the effect of the treatment system on the target site.

[00107] In embodiments, the treatment system may include one or more of an ablation system, a neuromodulation device, a neuromodulation implant, an ablation catheter, a focused energy delivery device, a radio frequency ablation system or catheter, a microwave ablation system or catheter, an ultrasound energy delivery system, a high intensity focused ultrasound (HIFU) delivery system or catheter, a cryoablation system or catheter, a chemical ablation system or catheter, a radiosurgical system, an optical ablation system, an infrared ablation system, a laser ablation system, an magnetic resonance (MR) guided HIFU system, or the like.

[00108] In embodiments, the algorithm may be configured to indicate when only a partial neuromodulation and/or ablation procedure has been performed on a target site, and/or when a complete procedure has been performed on the target site.

[00109] In embodiments, one or more of the monitoring devices may include a chemical agent selected from an endothermic reactive specie, an exothermic reactive specie, a local analgesic, a neuro-blocker, a neurotoxin, or a neural agonist for delivery to the associated monitoring site when coupled thereto, the algorithm configured to compensate for the presence of the chemical agent in the analysis of the activity signal(s).

[00110] In embodiments, the system may include a stimulating device selected from an electrical stimulator, a thermoregulating device, a heating coil, a thermoelectric device, a Peltier device, a tactile stimulating component, a vibratory stimulating element, a combination thereof, or the like, the stimulating device configured to stimulate the subject at one or more stimulation sites, the algorithm configured to compensate for the stimulation in the analysis.

[00111] In embodiments, one or more of the monitoring devices and/or one or more of the stimulating devices may be embedded into or included in the treatment system.

[00112] In embodiments, the treatment system may be configured to deliver a stimulating energy or chemical agent to the target site, and/or one or more stimulatory sites within the subject.

WHAT IS CLAIMED IS:

1. A patch interface, comprising:

a substrate with a surface;

an adhesive coupled to the substrate, the adhesive being formulated for attachment to the skin of a subject;

an interconnect embedded into or coupled to the substrate, the interconnect being configured for attachment of the patch interface to a microcircuit; and

a plurality of microelectrodes attached to or embedded into the surface of the substrate and electrically coupled with the microcircuit via the interconnect; and

one or more macroelectrodes electrically coupled with the microcircuit via the interconnect;

wherein the patch interface is configured to monitor neural activity from the skin of the subject;

wherein the microcircuit comprises two or more processing banks, a first one of the two or more processing banks being coupled to:

at least a first one of the one or more macroelectrodes; and

a first subset of the plurality of microelectrodes; and

wherein the first processing bank comprises a first preamplifier bank and a first switch bank, the first switch bank being configured to selectively connect one or more of the microelectrodes in the first subset of the plurality of microelectrodes and the first macroelectrode to the first preamplifier bank, the first preamplifier bank comprising one or more conditioning circuits configured to utilize signals measured by the first macroelectrode to remove at least one of one or more stretch artifacts and one or more movement artifacts from signals measured by the connected one or more microelectrodes in the first subset of the plurality of microelectrodes.

2. The patch interface in accordance with claim 1, wherein the adhesive is patterned onto the substrate to form one or more exposed regions of the substrate, one or more of the plurality of microelectrodes arranged within the exposed regions; and wherein the adhesive comprises one of an electrically conducting and an ionically conducting component.

3. The patch interface in accordance with claim 1, wherein the one or more macroelectrodes provide at least one of a guard function, a reference function, and a counter electrode function for one or more of the microelectrodes.

4. The patch interface in accordance with claim 1, wherein one or more of the plurality of microelectrodes is configured to penetrate into the skin when the adhesive is attached to the subject.

5. The patch interface in accordance with claim 1, wherein one or more of the plurality of microelectrodes has a needle-like shape, the microelectrode comprising an insulated region and an exposed region.

6. The patch interface in accordance with claim 5, wherein a given one of the plurality of microelectrodes is configured with a length to position the exposed region within at least one of an epidermal layer, a dermal layer, and a hypodermal layer of the skin upon attachment of the patch interface to the surface of the skin of the subject.

7. The patch interface in accordance with claim 5, wherein one or more of the plurality of microelectrodes is shaped to penetrate down a root of a follicle to reach at least one of a sweat gland, a sebaceous gland, a muscle, a vessel, and an arrector pili follicular muscle upon attachment of the patch interface to the skin.

8. The patch interface in accordance with claim 1, wherein a given one of the plurality of microelectrodes comprises an electrode feature configured to improve an electrical connection between the given microelectrode and the skin of the subject when upon placement on a subject and after pressure is applied to the given microelectrode.

9. The patch interface in accordance with claim 1, wherein one or more of the plurality of microelectrodes are configured and shaped to penetrate into the skin during

engagement therewith one of less than 3mm, less than 2mm into the skin, less than 1mm, less than 0.5mm, and less than 0.2mm.

10. The patch interface in accordance with claim 1, wherein one or more of the plurality of microelectrodes have exposed regions, and wherein the exposed regions of the one or more microelectrodes have an active surface area of one of less than $4mm^2$, less than $1mm^2$, less than $100,000um^2$, less than $10,000um^2$, less than $1,000um^2$, and less than $100um^2$.

11. The patch interface in accordance with claim 1, wherein the one or more macroelectrodes have an active surface area of one of greater than $5mm^2$, greater than $50mm^2$, greater than $100mm^2$, and greater than $500mm^2$.

12. The patch interface in accordance with claim 11, wherein the one or more macroelectrodes are shaped and patterned on the substrate to reduce movement artifacts, monitor a macroscopic electrophysiologic field, provide a reference electrode function, provide a guard electrode function, provide a drive electrode function, or a combination thereof during use.

13. The patch interface in accordance with claim 1, further comprising a sensor coupled with the substrate, and electrically coupled with the microcircuit, the sensor configured to monitor one or more physiologic parameters of the subject when coupled thereto.

14. The patch interface in accordance with claim 13, wherein the sensor comprises an electrophysiologic sensor, a temperature sensor, a thermal gradient sensor, a barometer, an altimeter, an accelerometer, a gyroscope, a humidity sensor, a magnetometer, an inclinometer, an oximeter, a colorimetric monitor, a sweat analyte sensor, a perfusion sensor, a galvanic skin response sensor, a hydration sensor, an interfacial pressure sensor, a flow sensor, a stretch sensor, a microphone, or a combination thereof.

15. The patch interface in accordance with claim 1, further comprising a stimulating device selected from an electrical stimulator, a thermoregulating device, a heating coil, a thermoelectric device, a Peltier device, a tactile stimulating component, a vibratory stimulating

element, or a combination thereof arranged along the substrate to interface with the skin of the subject when the adhesive is attached thereto.

16. The patch interface in accordance with claim 15, further comprising a feedback sensor coupled with the stimulating device, configured and arranged to monitor the interaction of the stimulating device with the skin during an activation of the stimulating device.

17. The patch interface in accordance with claim 1, further comprising one or more stretchable electrically conducting traces attached to the substrate, arranged to couple one or more sensors, microelectrodes, and macroelectrodes with one of the interconnect and the microcircuit.

18. The patch interface in accordance with claim 1, wherein the patch interface is configured to not retain a predetermined shape in a free standing state.

19. The patch interface in accordance with claim 18, further comprising a temporary stiffening member attached to the substrate, the temporary stiffening member configured to provide retention of the shape of the patch interface prior to attachment to the subject, the stiffening member being removable from the substrate after attachment to the subject.

20. The patch interface in accordance with claim 1, wherein the substrate is formed from a soft pseudo-elastic material and the patch interface is configured to maintain operation when stretched to one of more than 25%, more than 50%, and more than 80%.

21. The patch interface in accordance with claim 1, wherein the substrate is formed from a material configured with a moisture vapor transmission rate of one of: between 200g/m^2/24hrs and 20,000g/m^2/24hrs; between 500g/m^2/24hrs and 12,000g/m^2/24hrs; and between 1,000g/m^2/24hrs and 8,000g/m^2/24hrs.

22. The patch interface in accordance with claim 1, wherein the adhesive includes one of an endothermic-reactive specie, an exothermic-reactive specie, a local analgesic, a neuro-blocker, a neurotoxin, a neural antagonist, and a neural agonist.

23. The patch interface of claim 1, wherein:

a second one of the two or more processing banks is coupled to:

at least a second one of the one or more macroelectrodes; and

a second subset of the plurality of microelectrodes; and

the second processing bank comprises a second preamplifier bank and a second switch bank, the second switch bank being configured to selectively connect one or more of the microelectrodes in the second subset of the plurality of microelectrodes and the second macroelectrode to the second preamplifier bank, the second preamplifier bank comprising one or more conditioning circuits configured to utilize signals measured by the second macroelectrode to remove at least one of one or more stretch artifacts and one or more movement artifacts from signals measured by the connected one or more microelectrodes in the second subset of the plurality of microelectrodes.

24. The patch interface of claim 23, wherein the first subset of the plurality of microelectrodes and the second subset of the plurality of microelectrodes are attached to or embedded into respective distinct portions of the substrate to interact with different regions of neural innervation of the subject when the adhesive is attached to the skin of the subject.

25. The patch interface of claim 23, wherein the first subset of the plurality of microelectrodes and the second subset of the plurality of microelectrodes are configured to interact with different neural structures of the subject when the adhesive is attached to the skin of the subject.

26. A module, comprising:

a housing;

a circuit board comprising one or more microcircuits, the circuit board coupled to the housing; and

a module interconnect coupled to one or more of the microcircuits, the module interconnect being configured for placement and coupling of the module onto a patch interface, the patch interface comprising:

a substrate with a surface;

an adhesive coupled to the substrate, the adhesive being formulated for attachment to the skin of a subject;

a patch interconnect embedded into or coupled to the substrate, the patch interconnect being configured for attachment of the patch interface to the microcircuit; and

a plurality of microelectrodes attached to or embedded into the surface of the substrate and electrically coupled with the microcircuit via the patch interconnect; and

one or more macroelectrodes electrically coupled with the microcircuit via the patch interconnect;

wherein the module is configured to monitor one or more of physiologic signals, physical signals, skin based neural activity, and electrophysiological signals from the subject;

wherein the microcircuit comprises two or more processing banks, a first one of the two or more processing banks being coupled to:

at least a first one of the one or more macroelectrodes; and

a first subset of the plurality of microelectrodes; and

wherein the first processing bank comprises a first preamplifier bank and a first switch bank, the first switch bank being configured to selectively connect one or more of the microelectrodes in the first subset of the plurality of microelectrodes and the first macroelectrode to the first preamplifier bank, the first preamplifier bank comprising one or more conditioning circuits configured to utilize signals measured by the first macroelectrode to remove at least one of one or more stretch artifacts and one or more movement artifacts from signals measured by the connected one or more microelectrodes in the first subset of the plurality of microelectrodes.

27. The module in accordance with claim 26, wherein the module comprises at least one of: one or more sensors and one or more microelectronics, configured to interface with a sensor included on the patch interface, at least one of the one or more sensors comprising at least one of: an electrophysiologic sensor, a temperature sensor, a thermal gradient sensor, a barometer, an altimeter, an accelerometer, a gyroscope, a humidity sensor, a magnetometer, an

inclinometer, an oximeter, a colorimetric monitor, a perfusion sensor, a sweat analyte sensor, a galvanic skin response sensor, an interfacial pressure sensor, a flow sensor, a stretch sensor, and a microphone.

28. The module in accordance with claim 26, further comprising a stimulating device selected from an electrical stimulator, a thermoregulating device, a heating coil, a thermoelectric device, a Peltier device, a tactile stimulating component, a vibratory stimulating element, or a combination thereof arranged along the substrate to interface with the skin of the subject when coupled to the patch interface.

29. The module in accordance with claim 26, wherein the module is hermetically sealed.

30. The module in accordance with claim 26, further comprising a gasket coupled to the circuit board, the gasket shaped to isolate a region formed by the module interconnect and the patch interface from a surrounding environment when the module is coupled with the patch interface.